

Application Number 10/816,378
Amendment dated May 21, 2008
Response to Office Action mailed February 21, 2008

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AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions and listings of claims in the application.

Listing of Claims:

Claim 1 (Currently Amended) A method comprising:
 storing a packet to one of a plurality of hold queues;
 monitoring a loading condition of a transmit queue by monitoring an amount of data
residing within the transmit queue;
 generating a time epoch based on the loading condition by (i) computing a transmission
time to deliver the amount of data in the transmit queue, (ii) computing a system load in units of
time ~~based on the transmission time by comparing the transmission time to a constant lower limit~~
and selectively setting the system load based on the comparison, and (iii) computing the time
epoch based on the system load and a previous time epoch; and
 transferring the packet from the one of the plurality of hold queues to the transmit queue
for delivery to a network device via a downstream channel in response to the time epoch.

Claim 2 (Cancelled)

Claim 3 (Cancelled)

Claim 4 (Cancelled)

Claim 5 (Currently Amended) The method of claim ~~[[4]]~~1, wherein selectively setting the
system load comprises setting the system load equal to the transmission time when the
transmission time exceeds the constant lower limit.

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Claim 6 (Currently Amended) The method of claim [[4]]1, wherein selectively setting the system load comprises setting the system load equal to the constant lower limit when the constant lower limit exceeds the transmission time.

Claim 7 (Previously Presented) The method of claim 1, wherein computing the time epoch comprises adding the system load to the previous time epoch.

Claim 8 (Original) The method of claim 1, further comprising:
associating the packet with a service flow;
identifying a service credit associated with the service flow, wherein the service credit represents a bandwidth allocation available for consumption by the service flow; and
assigning the packet to one of the plurality of hold queues based on the identified service credit.

Claim 9 (Original) The method of claim 8, wherein assigning the packet comprises assigning an initial packet associated with the service flow to the transmit queue.

Claim 10 (Original) The method of claim 8, wherein assigning the packet comprises:
identifying a target queue state associated with the service flow, wherein the target queue state specifies a current priority level associated with the service flow; and
selecting the one of the plurality of hold queues based on the target queue state.

Claim 11 (Original) The method of claim 8, wherein assigning the packet comprises:
comparing the service credit to the size of the packet; and
selectively assigning the packet to the one of the plurality of hold queues based on the comparison.

Claim 12 (Original) The method of claim 11, wherein selectively assigning the packet comprises assigning the packet to the one of the plurality of hold queues when the service credit is greater than or equal to the size of the packet.

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Claim 13 (Original) The method of claim 11, further comprising adjusting the service credit by subtracting the size of the packet from the service credit.

Claim 14 (Original) The method of claim 11, wherein selectively assigning the packet comprises:
comparing the service credit to the size of the packet; and
selecting a different one of the plurality of hold queues when the service credit is less than the size of the packet.

Claim 15 (Original) The method of claim 14, wherein selecting a different one of the plurality of hold queues comprises:
adjusting the service credit; and
selecting the different one of the hold queues based on the adjusted service credit.

Claim 16 (Original) The method of claim 15, wherein adjusting the service credit comprises:
defining a set of configurable service classes;
pre-computing service quanta for each service class in the set, wherein the service quantum represents a pre-computed bandwidth adjustment for different network loading conditions;
associating the packet with one of the service classes;
selecting one of the pre-computed service quanta based on the one of the service classes associated with the packet and a current network loading condition; and
adjusting the service credit based on the selected one of the pre-computed service quanta.

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Claim 17 (Original) The method of claim 14, further comprising:

identifying a target queue state associated with the service flow, wherein the target queue state specifies a current priority level associated with the service flow;

adjusting the target queue state associated with the service flow to demote the target queue state by one or more priority levels; and

selecting the different one of the plurality of hold queues based on the adjusted target queue state.

Claim 18 (Previously Presented) The method of claim 17, wherein adjusting the target queue state comprises:

identifying a service class associated with the packet;

monitoring the loading condition of the transmit queue;

adjusting the service credit based on the determined service class and the monitored loading condition; and

selecting the different one of the plurality of hold queues based on the adjusted service credit and the adjusted target queue state.

Claim 19 (Previously Presented) The method of claim 18, wherein monitoring the loading condition comprises monitoring the amount of data residing within the transmit queue.

Claim 20 (Original) The method of claim 17, further comprising:

comparing the adjusted target queue state to a lowest priority level; and

dropping the packet when the adjusted target queue state is less than the lowest priority level.

Claim 21 (Original) The method of claim 1, further comprising transmitting the packet from the transmit queue to the network device via the downstream channel.

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Claim 22 (Original) The method of claim 21, wherein transmitting the packet comprises assigning a queue state to each one of the plurality of hold queues, wherein the queue state represents a priority level for the respective hold queue.

Claim 23 (Original) The method of claim 22, further comprising reassigning the queue state assigned to each one of the plurality of hold queues in response to the time epoch.

Claim 24 (Original) The method of claim 23, wherein reassigning the queue state comprises:
demoting the queue state of the highest priority one of the plurality of hold queues to the queue state of the lowest priority one of the plurality of hold queues; and
promoting the queue states of the remaining hold queues by a priority level.

Claim 25 (Currently Amended) A computer-readable storage medium comprising that stores instructions for causing a programmable processor to:
store a packet to one of a plurality of hold queues;
monitor a loading condition of a transmit queue by monitoring an amount of data residing within the transmit queue;
generate a time epoch based on the loading condition by (i) computing a transmission time to deliver the amount of data in the transmit queue, (ii) computing a system load in units of time based on the transmission time by comparing the transmission time to a constant lower limit and selectively setting the system load based on the comparison, and (iii) computing the time epoch based on the system load and a previous time epoch; and
transfer the packet from the one of the plurality of hold queues to the transmit queue for delivery to a network device via a downstream channel in response to the time epoch.

Claim 26 (Cancelled)

Claim 27 (Cancelled)

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Claim 28 (Currently Amended) The computer-readable storage medium of claim 25, further ~~comprising~~ storing instructions to cause the processor to:

associate the packet with a service flow;
identify a service credit associated with the service flow, wherein the service credit represents a bandwidth allocation available for consumption by the service flow; and
assign the packet to one of the plurality of hold queues based on the identified service credit.

Claim 29 (Currently Amended) The computer-readable storage medium of claim 28, further ~~comprising~~ storing instructions to cause the processor to transmit the packet via the downstream channel to the network device.

Claim 30 (Currently Amended) A device comprising a control unit that stores packets from a variable number of service flows to one of a static number of hold queues, monitors a loading condition of a transmit queue by monitoring an amount of data in a transmit queue, generates a time epoch based on the loading condition by (i) computing a transmission time to deliver the amount of data in the transmit queue, (ii) computing a system load in units of time based on the transmission time by comparing the transmission time to a constant lower limit and selectively setting the system load based on the comparison, and (iii) computing the time epoch based on the system load and a previous time epoch, and transfers the packet from the one of the static number of hold queues to the transmit queue for delivery to a network device via a downstream channel in response to the time epoch.

Claim 31 (Cancelled)

Claim 32 (Cancelled)

Claim 33 (Cancelled)

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Claim 34 (Currently Amended) The method of claim ~~[[33]]~~30, wherein the control unit selectively sets the system load by setting the system load equal to the transmission time when the transmission time exceeds the constant lower limit.

Claim 35 (Currently Amended) The method of claim ~~[[33]]~~30, wherein the control unit selectively sets the system load by setting the system load equal to the constant lower limit when the constant lower limit exceeds the transmission time.

Claim 36 (Previously Presented) The method of claim 30, wherein the control unit computes the time epoch by adding the system load to the previous time epoch.

Claim 37 (Previously Presented) The device of claim 30, wherein the control unit further identifies service credits associated with the variable number of service flows, wherein the service credits represent a bandwidth allocation available for consumption by the variable number of service flows, and assigns the packets to the static number of hold queues based on the identified service credits.

Claim 38 (Original) The device of claim 37, wherein the control unit further assigns initial packets associated with the variable number of service flows to the transmit queue.

Claim 39 (Original) The device of claim 37, wherein the control unit assigns one of the packets by identifying a target queue state associated with one of the service flows, wherein the target queue state specifies a current priority level associated with the one of the service flows, and selecting one of the static number of hold queues based on the target queue state.

Claim 40 (Original) The device of claim 39, wherein the control unit assigns one of the packets by comparing one of the service credits to the size of the one of the packets, and selectively assigning the one of the packets to the one of the static number of hold queues based on the comparisons.

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Claim 41 (Original) The device of claim 40, wherein the control unit selectively assigns one of the packets by assigning the one of the packets to the one of the static number of hold queues when the one of the service credits is greater than or equal to the size of the one of the packets.

Claim 42 (Original) The device of claim 40, wherein the control unit adjusts the one of the service credits by subtracting the size of the one of the packets from the one of the service credits.

Claim 43 (Original) The device of claim 40, wherein the control unit selectively assigns the one of the packets by comparing the one of the service credits to the size of the one of the packets, and selecting a different one of the static number of hold queues when the one of the service credits are less than the size of the one of the packets.

Claim 44 (Original) The device of claim 43, wherein the control unit selects a different one of the static number of hold queues by adjusting the one of the service credits, and selecting the different one of the hold queues based on the adjusted one of the service credits.

Claim 45 (Original) The device of claim 44, wherein the control unit adjusts the one of the service credits by:

- defining a set of configurable service classes,

- pre-computing service quanta for each service class in the set, wherein the service quantum represents a pre-computed bandwidth adjustment for different network loading conditions,

- associating the one of the packets with one of the service classes, selecting one of the pre-computed service quanta based on the one of the service classes associated with the one of the packets and a current network loading condition, and

- adjusting the one of the service credits based on the selected one of the pre-computed service quanta.

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Claim 46 (Original) The device of claim 44,

wherein the control unit identifies target queue states associated with the service flows,
wherein the target queue states specify current priority levels associated with the service flows,
and

wherein the control unit adjusts the target queue states associated with the service flows
to demote the target queue states one or more priority levels, and selects the different one or more
of the static number of hold queues based on the adjusted target queue states.

Claim 47 (Previously Presented) The device of claim 46, wherein the control unit adjusts the
target queue states by identifying service classes associated with the packets, monitoring the
loading condition of the transmit queue, adjusting the service credits based on the determined
service class and the monitored loading condition, and selecting the different one or more of the
plurality of hold queues based on the adjusted service credits and the adjusted target queue states.

Claim 48 (Original) The device of claim 47, wherein the control unit monitors the loading
condition by monitoring the amount of data residing within the transmit queue.

Claim 49 (Original) The device of claim 46, wherein the control unit compares the adjusted
target queue states to a lowest priority level, and drops the packet when the adjusted target queue
states are less than the lowest priority level.

Claim 50 (Original) The device of claim 30, wherein the control unit transmits the packets via
the downstream channel to the network device.

Claim 51 (Original) The device of claim 50, wherein the control unit transmits the packets by
assigning a queue state to each one of the static number of hold queues, wherein the queue state
represents a priority level for the respective hold queue.

Claim 52 (Original) The device of claim 51, wherein the control unit reassigns the queue state
assigned to each one of the static number of hold queues in response to the time epoch.

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Claim 53 (Original) The device of claim 52, wherein the control unit reassigns the queue state by demoting the queue state of the highest priority one of the static number of hold queues to the queue state of the lowest priority one of the static number of hold queues, and promoting the queue states of the remaining hold queues by a priority level.

Claim 54 (Currently Amended) A system comprising:
a cable modem; and
a cable modem termination system comprising:
a downstream scheduler that includes a transmit queue,
a load monitor that monitors a loading condition of the transmit queue by monitoring an amount of data residing within the transmit queue and generates a time epoch based on the loading condition by (i) computing a transmission time to deliver the amount of data in the transmit queue, (ii) computing a system load in units of time based on the transmission time by comparing the transmission time to a constant lower limit and selectively setting the system load based on the comparison, and (iii) computing the time epoch based on the system load and a previous time epoch, and
a queue assignment module that stores a packet to one of a plurality of hold queues, and transfers the packet from the one of the plurality of hold queues to the transmit queue for delivery to the cable modem via a downstream channel in response to the time epoch.

Claim 55 (Cancelled)

Claim 56 (Cancelled)

Claim 57 (Cancelled)

Claim 58 (Currently Amended) The system of claim ~~[[57]]~~54, wherein the load monitor selectively sets the system load by setting the system load equal to the transmission time when the transmission time exceeds the constant lower limit.

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Claim 59 (Currently Amended) The system of claim ~~[[57]]~~54, wherein the load monitor selectively sets the system load by setting the system load equal to the constant lower limit when the constant lower limit exceeds the transmission time.

Claim 60 (Previously Presented) The system of claim 54, wherein the load monitor computes the time epoch by adding the system load to the previous time epoch.

Claim 61 (Original) The system of claim 54, wherein the queue assignment module associates the packet with a service flow, identifies a service credit associated with the service flow, wherein the service credit represents a bandwidth allocation available for consumption by the service flow, and assigns the packet to one of a plurality of hold queues based on the identified service credit.

Claim 62 (Original) The system of claim 61, wherein the queue assignment module assigns an initial packet associated with the service flow to the transmit queue.

Claim 63 (Original) The system of claim 61, wherein the queue assignment module further identifies a target queue state associated with the service flow, wherein the target queue state specifies a current priority level associated with the service flow, and selects one of the plurality of hold queues based on the target queue state.

Claim 64 (Original) The system of claim 63, wherein the queue assignment module adjusts the target queue state by identifying a service class associated with the packet, adjusting the service credit based on the determined service class and the loading condition monitored by the load monitor, and selecting the different one of the plurality of hold queues based on the adjusted service credit and the adjusted target queue state.

Claim 65 (Original) The system of claim 64, wherein the queue assignment module further compares the adjusted target queue state to a lowest priority level, and drops the packet when the adjusted target queue state is less than the lowest priority level.

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Claim 66 (Original) The system of claim 61, wherein the queue assignment module further compares the service credit to the size of the packet, and selectively assigns the packet to one of the plurality of hold queues based on the comparison.

Claim 67 (Original) The system of claim 66, wherein the queue assignment module assigns the packet to one of the plurality of hold queues when the service credit is greater than or equal to the size of the packet.

Claim 68 (Original) The system of claim 67, wherein the queue assignment module adjusts the service credit upon assigning the packet by subtracting the size of the packet from the service credit.

Claim 69 (Original) The system of claim 68, wherein the queue assignment module compares the service credit to the size of the packet and selects a different one of the plurality of hold queues when the service credit is less than the size of the packet.

Claim 70 (Original) The system of claim 68, wherein the queue assignment module adjusts the service credit and selects a different one of the plurality of hold queues based on the adjusted service credit.

Claim 71 (Original) The system of claim 70, wherein the queue assignment module adjusts the service credit by:

- defining a set of configurable service classes,
- pre-computing service quanta for each service class in the set, wherein the service quantum represents a pre-computed bandwidth adjustment for different network loading conditions,
- associating the packet with one of the service classes,
- selecting one of the pre-computed service quanta based on the one of the service classes associated with the packet and a current network loading condition, and
- adjusting the service credit based on the selected one of the pre-computed service quanta.

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Claim 72 (Original) The system of claim 54, wherein the downstream scheduler further includes a queue transition module that assigns a queue state to each one of the plurality of hold queues, wherein the queue state represents a priority level for the respective hold queue.

Claim 73 (Original) The system of claim 72, wherein the queue transition module further reassigns the queue state assigned to each one of the plurality of hold queues in response to the time epoch generated by the load monitor.

Claim 74 (Original) The system of claim 73, wherein the queue transition module reassigns the queue state by demoting the queue state of the highest priority one of the plurality of hold queues to the queue state of the lowest priority one of the plurality of hold queues, and promoting the queue states of the remaining hold queues by a priority level.

Claim 75 (Original) The system of claim 54, wherein the downstream scheduler transmits the packet via a downstream channel to the cable modem.

Claim 76 (New) A method comprising:

storing a packet to one of a plurality of hold queues;

monitoring a loading condition of a transmit queue by monitoring an amount of data residing within the transmit queue;

generating a time epoch based on the loading condition by (i) computing a transmission time to deliver the amount of data in the transmit queue, (ii) computing a system load in units of time based on the transmission time, and (iii) computing the time epoch by adding the system load to a previous time epoch; and

transferring the packet from the one of the plurality of hold queues to the transmit queue for delivery to a network device via a downstream channel in response to the time epoch.

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Claim 77 (New) A device comprising a control unit that stores packets from a variable number of service flows to one of a static number of hold queues, monitors a loading condition of a transmit queue by monitoring an amount of data in a transmit queue, generates a time epoch based on the loading condition by (i) computing a transmission time to deliver the amount of data in the transmit queue, (ii) computing a system load in units of time based on the transmission time, and (iii) computing the time epoch by adding the system load to a previous time epoch, and transfers the packet from the one of the static number of hold queues to the transmit queue for delivery to a network device via a downstream channel in response to the time epoch.

Claim 78 (New) A system comprising:
a cable modem; and
a cable modem termination system comprising:
a downstream scheduler that includes a transmit queue,
a load monitor that monitors a loading condition of the transmit queue by monitoring an amount of data residing within the transmit queue and generates a time epoch based on the loading condition by (i) computing a transmission time to deliver the amount of data in the transmit queue, (ii) computing a system load in units of time based on the transmission time, and (iii) computing the time epoch by adding the system load to a previous time epoch, and
a queue assignment module that stores a packet to one of a plurality of hold queues, and transfers the packet from the one of the plurality of hold queues to the transmit queue for delivery to the cable modem via a downstream channel in response to the time epoch.